RF Project 1760
Report 1

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SEMI-ANNUAL

REPORT

by

THE OHIO STATE UNIVERSITY
RESEARCH FOUNDATION
Columbus, Ohio 43212

To: NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington 25, D.C.
Contract No. SC-NsG-552

On: MEASUREMENT OF ANGULAR ROTATION WITH PHOTONS Report No. 1

For the period: 1 October 1963 - 31 March 1964

Submitted by: C. V. Heer 6 apr. 1964 3 p orego
Department of Physics

Date: 6 April 1964

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MEASUREMENT OF ANGULAR ROTATION WITH PHOTONS

INTRODUCTION

This report concerns the progress during the past six months on the investigation supported by Grant NsG-552 for the theoretical and experimental investigation of the measurement of angular rotation with photons. Because of the delay in the initial funding of the program, the level of activity was restricted during the first few months. Recent progress is reported in the following subsections.

EXPERIMENTAL PROGRAM

During November 1963, Mr. P. K. Cheo completed work for his Ph.D. dissertation on the experimental apparatus for the measurement of angular rotation with photons. His research investigation yielded a number of interesting results. A square cavity with alll mirrors aluminized and flat to 1/80 wave was aligned to form a 92 x 92 cm square resonant structure. The insertion of a He-Ne maser using the 3.39-micron line provided a gain so large that oscillation took place with reasonable alignment procedures. Rotation produced beats between the clockwise and counter-clockwise modes of

$$\Delta\nu/\nu = \Omega\, D/c,$$

where Ω is the angular rotation rate, D is the diameter of the square, and c is the velocity of light. The cavity with four plane mirrors provided a remarkable improvement over the previous confocal system. The beat signal was very stable and its intensity increased as the maser approached power saturation. Beat signals as large as 70% of the dc signal were observed. This experimental arrangement also allowed us to study in greater detail the phenomenon referred to as 'bias', which is the observation of beats in the absence of rotation. Preliminary reports of these investigations are being presented by Cheo and Heer (P. K. Cheo and C. V. Heer, Appl. Optics, to be published, also Bull. Am. Phys. Soc., Washington meeting, 1964).

Mr. John Little, a research fellow under this program working toward his Ph.D. degree, has continued the investigations of Cheo on bias. Bias beats can be introduced by the insertion of an object into a portion of the maser beam, and it is possible to tune the difference frequency between the clockwise and counter-clockwise beams by the degree of insertion of a razor blade into the beam. It is apparent from these studies that small dust particles, edges, and other objects affect one beam more strongly than the other and cause beats. A study of such diffraction edges is being continued and an understanding of their effect should permit better operation at low rates of angular rotation.

For extended measurements it was apparent that the original design did not permit rapid and easy adjustment of the mirrors. The past two months have been spent in rebuilding the apparatus. New mirror mounts with micrometer adjustments and larger mirrors are being used. A better design for r-f excitation is being incorporated into the apparatus.

Lt. William P. Howell, an Air Force Officer working toward the M. Sc. degree, is investigating the properties of the He-Xe maser. The large mass of Xe and its smaller doppler width make it an attractive maser medium. In a maser tube of conventional design, the xenon is driven into the walls in a few hours and the maser action of the system ceases. A design which keeps the xenon pressure constant is being studied by Lt. Howell.

THEORETICAL PROGRAM

Professor Heer has continued his study of the effect of macroscopic matter on the resonant frequencies of electromagnetic cavities in an accelerated system of reference. A paper developed during the past year is being published in the near future in the Physical Review. (C. V. Heer, Phys. Rev., to be published in May 1964). Since a large portion of this paper was prepared prior to this grant, the support from this grant is acknowledged "in part." This acknowledgment was made in the proof and therefor no copy or copies were submitted to NASA. Twenty-five copies of reprints will be forwarded when they become available.

PERSONNEL

C. V. Heer, Supervisor	-	Without compensation
John Little, Research Fellow	-	Half-time five months
Lt. William P. Howell	-	Without Compensation

Investigator C. V. Heer Date 4/14/64

Supervisor C. V. Heer Date 4/14/64

For The Ohio State University Research Foundation

Executive Director Robert C. Stephenson Date 4/16/64